PHYSICAL SCIENCES

Grade10

TERM 4

Content Booklet

TARGETED SUPPORT

Contents

A Message from the NECT

National Education Collaboration Trust (NECT)

Dear Teachers

This learning programme and training is provided by the National Education Collaboration Trust (NECT) on behalf of the Department of Basic Education (DBE)! We hope that this programme provides you with additional skills, methodologies and content knowledge that you can use to teach your learners more effectively.

What is NECT?

In 2012 our government launched the National Development Plan (NDP) as a way to eliminate poverty and reduce inequality by the year 2030. Improving education is an important goal in the NDP which states that 90% of learners will pass Maths, Science and languages with at least 50% by 2030. This is a very ambitious goal for the DBE to achieve on its own, so the NECT was established in 2015 to assist in improving education and to help the DBE reach the NDP goals.

The NECT has successfully brought together groups of relevant people so that we can work collaboratively to improve education. These groups include the teacher unions, businesses, religious groups, trusts, foundations and NGOs.

What are the Learning programmes?

One of the programmes that the NECT implements on behalf of the DBE is the 'District Development Programme'. This programme works directly with district officials, principals, teachers, parents and learners; you are all part of this programme!

The programme began in 2015 with a small group of schools called the Fresh Start Schools (FSS). Curriculum learning programmes were developed for Maths, Science and Language teachers in FSS who received training and support on their implementation. The FSS teachers remain part of the programme, and we encourage them to mentor and share their experience with other teachers.

The FSS helped the DBE trial the NECT learning programmes so that they could be improved and used by many more teachers. NECT has already begun this embedding process.

Everyone using the learning programmes comes from one of these groups; but you are now brought together in the spirit of collaboration that defines the manner in which the NECT works. Teachers with more experience using the learning programmes will deepen their knowledge and understanding, while some teachers will be experiencing the learning programmes for the first time.

Let's work together constructively in the spirit of collaboration so that
we can help South Africa eliminate poverty and improve education!
www.nect.org.za

PROGRAMME ORIENTATION

Programme Orientation

Welcome to the NECT Physical Sciences learning programme! This CAPS compliant programme consists of:

- A Content Booklet: Targeted Support
- A Resource Pack Booklet which consists of worksheets, a guide to formal experiments and/or investigations, formal assessment support.
- A DVD with a video of the formal experiments and/or investigation.
- A set of posters.

Overview and Approach of Programme

The FET Physical Sciences curriculum is long and complex. There are many quality textbooks and teachers' guides available for use. This programme does not aim to replace these resources, but rather, to supplement them in a manner that will assist teachers to deliver high quality Physical Sciences lessons.

Essentially, this programme aims to provide targeted support to teachers by doing the following:

1. Clarifying and explaining key concepts.
2. Clarifying and explaining possible misconceptions.
3. Providing worked examples of questions at an introductory level.
4. Providing worked examples of questions at a challenge level.
5. Providing the key teaching points to help learners deal with questions at challenge level.
6. Providing worksheet examples and corresponding marking guidelines for each topic.
7. Providing a Planner & Tracker that helps teachers to plan their lessons for a topic, and track their progress, pacing and curriculum coverage.
8. Providing videos of formal experiments and/or investigations, together with learners' worksheets and marking guidelines.
9. Providing guidance on how to structure formal assessment tasks.
10. Providing a 'bank' of questions and marking guidelines that may be used to structure formal assessment tasks.
11. Providing a set of posters with key information to display in the classroom.

Content Booklet: Targeted Support

1. The booklet starts with a ***contents page*** that lists all the topics for the term.
2. Every topic begins with a ***general introduction*** that states for how long the topic runs and the value of the topic in the final exam. It also gives a general idea of what is covered in the topic, and why this is important for our everyday lives.
3. This is followed by a ***list of requirements*** for the teacher and the learner. Try to ensure that you have all requirements on hand for the topic, and that your learners always have their requirements ready for each lesson. This is a simple classroom management practice that can improve your time-on-task and curriculum coverage significantly!
4. Next, you will see a ***sequential table*** that shows the prior knowledge required for this topic, the current knowledge and skills that will be covered, and how this topic will be built on in future years. Use this table to give learners an informal quiz to test their prior knowledge. If learners are clearly lacking in the knowledge and skills required, you may need to take a lesson to cover some of the essential content and skills. It is also useful to see what you are preparing learners for in the years to follow, by closely examining the 'looking forward' column.
5. This is followed by a ***glossary of terms***, together with an explanation of each term. It is a good idea to display these words and their definitions somewhere in the classroom, for the duration of the topic. It is also a good idea to allow learners some time to copy down these definitions into their books. You must teach the words and their meanings explicitly as and when you encounter these words in the topic.

   Once you have taught a new word or phrase, try to use it frequently in statements and questions. It takes the average person 20 – 25 authentic encounters with a new word to fully adopt it and make it their own.
6. Next, there are some very brief notes about the ***assessment*** of this topic. This just informs you of when the topic will be assessed, and of the kinds of questions that are usually asked. Assessment is dealt with in detail in the Assessment Section of the Resource Pack.
7. The next item is very useful and important. It is a table showing the ***breakdown of the topic and the targeted support offered.***

   This table lists the ***sub-topic***, the classroom ***time allocation*** for the sub-topic, and the ***CAPS page reference***.

   The table also clearly states the ***targeted support*** that is offered in this booklet. You will see that there are three main kinds of support offered:

   a. Key concepts are clarified and explained.

   b. Possible misconceptions are clarified and explained.

   c. Questions are modelled and practised at different levels (introductory level and challenge level).

8. After this introduction, the ***targeted support for each sub-topic*** commences. This generally follows the same routine:
   a. A key concept or key concepts are clarified and explained. It may be useful for you to work through this carefully with learners, and do any demonstrations that are included.
   b. Questions related to the key concepts are worked and explained.
      - These questions may be done at introductory level, at challenge level, or both.
      - It is important to expose learners to **challenge level questions**, as this is often how questions are presented in exams.
      - These questions also challenge learners to apply what they have learnt about key concepts. Learners are, essentially, challenged to think at a critical and analytical level when solving these problems.
      - Please note that when calculations are done at challenge level, the key teaching points are identified.
      - Make sure that you effectively share these key teaching points with learners, as this can make all the difference as to whether learners cope with challenge level questions or not.
   c. At key points in the topic, checkpoints are introduced.
      - These checkpoints involve asking learners questions to check that they understand everything to that point.
      - The checkpoints also refer to a worksheet activity that is included in the Worksheet Section of the Resource Pack.
      - Use checkpoints to ascertain whether more consolidation must be done, or if your learners are ready to move to the next key concept.
9. Every topic ends with a ***consolidation exercise*** in the Worksheet Section of the Resource Pack. This exercise is not scaffolded as a test, it is just a consolidation of everything covered in this programme for that topic.
10. Finally, a section on ***additional reading / viewing*** rounds off every topic. This is a series of web links related to the topic. Please visit these links to learn more about the topic, and to discover interesting video clips, tutorials and other items that you may want to share with your learners.

The Worksheet Section of the Resource Pack

1. The Worksheet Section has different worksheets and corresponding marking guidelines for each topic.
2. First, there is a ***practice worksheet***, with questions that learners must complete during the topic. These are referred to in the checkpoints.
3. Once learners have completed these calculations, it is important to mark their work, using the ***marking guidelines*** supplied. Either do this together as a whole class, or display copies of the marking guidelines around the classroom, in spaces where learners can go and mark their work for themselves.
4. It is important that learners see how marks are allocated in the marking guidelines, so that they fully understand how to answer questions in tests and exams.
5. At the end of each topic, there is a ***consolidation exercise*** and marking guidelines. This worksheet is a consolidation exercise of all the concepts covered in the topic. The consolidation exercise is NOT scaffolded and it is not designed to be used as a formal test. The level of the worksheet will be too high to be used as a test.
6. Again, it is important for learners to mark their work, and to understand how marks are allocated for each question.
7. Please remember that these worksheets do not replace textbook activities. Rather, they supplement and extend the activities that are offered in the textbook.

The Planner & Tracker

1. The Planner & Tracker is a useful tool that will help you to effectively plan your teaching programme to ensure that it is CAPS compliant.
2. The Planner & Tracker has a section for every approved textbook, so that regardless of the textbook that you use, you will be able to use this tool.
3. It also has space for you to record all lessons completed, which effectively allows you to monitor your curriculum coverage and pacing.
4. In addition, there is space for you to reflect on your progress and challenges at the end of each week.
5. At the end of the Planner & Tracker, you will find a series of resources that may be useful to you when teaching.
6. You will also find a sample formal assessment and marking guidelines.

The Formal Experiments and/or Investigations and DVD

1. The following experiments or investigations must be completed as part of the formal assessment programme:
   - **a.** Grade 10 Term 1: Heating and cooling curve of water
   - **b.** Grade 10 Term 2: Electric circuits with resistors in series and parallel – measuring potential difference and current
   - **c.** Grade 10 Term 3: Acceleration
   - **d.** Grade 11 Term 1: Verification of Newton's 2nd Law: Relationship between force and acceleration
   - **e.** Grade 11 Term 2: The effects of intermolecular forces on: BP, surface tension, solubility, rate of evaporation
   - **f.** Grade 12 Term 1: Preparation of esters
   - **g.** Grade 12 Term 2: 1) Titration of oxalic acid against sodium hydroxide
     2) Conservation of linear momentum
   - **h.** Grade 12 Term 3: a) Determine the internal resistance of a battery
     b) Set up a series-parallel network with known resistor. Determine the equivalent resistance using an ammeter and a voltmeter and compare with the theoretical value.
2. Videos of all the listed experiments and investigations are supplied as part of this programme.
3. These videos should ideally be used as a teacher's guide. After watching the video, set up and complete the practical with your learners. However, if this is not possible, then try to show the video to your learners and allow them to record and analyse results on their own.
4. The videos should be used in conjunction with the experiment (or investigation) learners' worksheets. Learners should complete the observations and results section of the worksheet while watching the video, and then work on their own to analyse and interpret these as instructed by the questions that follow on the worksheet.

The Posters

1. Every FET Physical Sciences teacher will be given the following set of five posters to display in the classroom:
   - **a.** Periodic Table
   - **b.** Chemistry Data Sheet
   - **c.** Physics Data Sheet Part 1

   d. Physics Data Sheet Part 2
   e. Chemistry Half Reactions

2. **Please note that you will only be given these posters once**. It is important for you to make these posters as durable as possible. Do this by:
   a. Writing your name on all posters
   b. Laminating posters, or covering them in contact paper

3. Have a dedicated wall or notice board in your classroom for Physical Sciences, per grade:
   - Use this space to display the posters
   - Display definitions and laws
   - Display any additional relevant or interesting articles or illustrations
   - Try to make this an attractive and interesting space

The Assessment Section of the Resource Pack

1. A separate Assessment Section is provided for Grade 10, Grade 11 and Grade 12.
2. This section provides you with a 'bank' of sample assessment questions for each topic.
3. These are followed by the marking guidelines for all the different questions that details the allocation of marks.
4. The level of cognitive demand is indicated for each question (or part of a question) in the marking guidelines as [CL1] for cognitive level 1 etc.

Planning and Preparation

1. Get into the habit of planning every topic by using the following documents together:
   a. The Physical Sciences Planner & Tracker
   b. The Content Booklet: Targeted Support
   c. The Worksheet Section of the Resource Pack
   d. Your textbook
2. Planning should always be done well in advance. This gives you the opportunity to not only feel well-prepared but also to ask a colleague for help if any problems arise.
3. Follow these steps as you plan to teach a topic:
   a. **Turn to the relevant section in the Planner & Tracker for your textbook.**
      - Look through the breakdown of lessons for the topic.
      - In pencil, fill in the dates that you plan to teach each lesson. This will help with your sequencing.

   b. **Next, turn to the relevant section in your Textbook.**
      - Read through each key concept in the Textbook.
      - Complete as many examples as possible. This will also help in your teaching – you will remember more points to share with the learners if you have done all of the work yourself.

   c. **Finally, look at the topic in the Content Booklet: Targeted Support.**
      - Read through all the introduction points, including the table that shows the breakdown of lessons, and the targeted support offered.
      - Take note of the targeted support that is offered for each section.
      - Read through the whole topic in the Content Booklet: Targeted Support.
      - Complete all the examples in the Worksheets for the topic, including the Consolidation Exercise.
      - Make notes in your Planner & Tacker to show where you will include the targeted support teaching and activities. You may choose to replace some textbook activities with work from the targeted support programme, but, be careful not to leave anything out!

   d. **Document your lesson plans in the way that you feel most comfortable.**
      - You may like to write notes about your lesson plans in a notebook.
      - You may like to use a standardised template for lesson planning. (A template is provided at the end of this section).
      - Remember to make notes about where you will use the textbook activities, and where you will use the targeted support activities.

e. Ideally, Lesson Planning for a topic should include:
- Time to introduce the topic to learners.
- Time to establish the learners' prior knowledge.
- If required, time to address critical gaps in learners' prior knowledge.
- Introduction of terminology (glossary words).
- Time to introduce and teach each key concept.
- Time for learners to complete practice exercises for each key concept.
- Time to correct and remediate each key concept.
- Time for a consolidation exercise.

Note: Avoid giving learners an exercise to do that you haven't already completed yourself. This is useful for when the learners ask questions or get stuck on a question, you will be ready to assist them immediately instead of wasting time reading the question and working it out then.

Preparation and Organisation

1. Once you have completed your planning for a topic, you must make sure that you are properly prepared and organised to teach it.
2. Do this by completing all the steps listed in the planning section, including completing all the textbook and worksheet examples.
3. Have your lesson plans or teaching notes ready to work from.
4. Next, make sure that you have all resources required for the lesson.
5. Prepare your notice board for the topic, to give learners something visual to anchor their learning on, and to generate interest around the topic.
6. Print copies of the worksheets for all learners.

SAMPLE TEMPLATE FOR LESSON PREPARATION

PHYSICAL SCIENCES LESSON PLAN

School	
Teacher's name	
Grade	
Term	
Topic	
Date	
Lesson Duration	

1. CONCEPTS AND SKILLS TO BE ACHIEVED:

By the end of the lesson learners should know and be able to:

2. RESOURCES REQUIRED:

3. HOMEWORK REVIEW / REFLECTION:

Exercises to be reviewed and notes:

4. LESSON CONTENT / CONCEPT DEVELOPMENT

Explanation and examples to be done:

5. CLASSWORK ACTIVITY

Resource 1	
Page	
Exercise	
Resource 2	
Page	
Exercise	

Notes:

6. HOMEWORK ALLOCATION

Resource 1	
Page	
Exercise	
Resource 2	
Page	
Exercise	

7. LESSON REFLECTION:

What went well:
What could have gone better:

Examination Preparation

Note: It is important to start preparing learners for their exam from the beginning of the term.

1. Make sure that your learners know exactly when their Physical Science examination will be written.
2. Ask learners to take out their exercise books, and to mark off what must be studied.
3. Go through all their written work, and get them to tick off the work that they must study and practise.
    a. If learners are missing notes, they must copy the missing work from another learner.
    b. As you complete more work during the term that will be in the exam, tell learners to tick it off and to add it to their study plans.
4. If necessary, help learners to work out a study schedule.
    a. Estimate how long learners will need to study all the content required for the examination. This will differ from grade to grade, and from learner to learner.
    b. Be aware that some learners, even in the FET stage, have not yet developed these planning skills.
    c. Tell learners the number of hours that you think they need to study before the examination.
    d. Break this down into the number of hours they should study each week.
    e. Tell learners to think about their own lives and habits, and to work out when they have time to study, and when they study best.
    f. They must then use all of this information to work out their study and revision plan.

USEFUL REVISION RESOURCES

1. **Assessment Section of the Resource Pack**
    a. The Assessment Section that forms part of this series may be used as a very useful examination preparation tool.
    b. This section includes a 'bank' of questions for each topic at the different conceptual levels.
    c. If your province or district provides standardised tests and exams, use the questions in this booklet at revision and exam preparation for learners.

d. Remember to carefully explain the question structure and meaning, together with the mark allocation.

2. **Vodacom e-school**

   a. If learners have a Vodacom number, they are eligible to use the Vodacom e-school as a free service, i.e. no data costs: http://www.vodacom.co.za/vodacom/test-templates/eschool-two

   b. This e-school includes Physical Science lessons as part of its curriculum.

   c. Tell learners how to access this useful resource.

TOPIC 22:
Energy

A Introduction

- This topic runs for 8 hours.
- For guidance on how to break down this topic into lessons, please consult the NECT Planner & Tracker.
- Energy forms part of the content area Mechanics (Physics).
- Mechanics counts as 50 % in the final exam.
- Energy counts approximately 29 % of the final Paper 1 (Physics) examination.
- The weighting of mechanics in the CAPS is 18,75 %.
- Understanding of energy and energy transfers is one of the most important concepts in science and economics in the world today. Mankind needs to find new solutions to solving the problems caused by decades of fossil fuel use. We can only solve problems if we truly understand the basic concepts. This topic presents basic concepts in energy.

CLASSROOM REQUIREMENTS FOR THE TEACHER

1. Chalkboard.
2. Chalk.
3. Grade 10 Physics Examination Data Sheet.
4. OPTIONAL: 1 m of light inextensible (inelastic) string attached to a ball, weight or stone. This will be used to carry out a demonstration on energy transfers using a pendulum bob. Ensure that the object (ball, weight or stone) is securely attached to the string. You can place it in a small plastic bag and attach the string to the bag.

CLASSROOM REQUIREMENTS FOR THE LEARNER

1. An A4 3-quire exercise book, for notes and exercises.
2. Scientific calculator – Sharp or Casio calculators are highly recommended.
3. Pen.
4. Grade 10 Physics Examination Data Sheet.

B Sequential Table

PRIOR KNOWLEDGE	CURRENT	LOOKING FORWARD
GRADE 7-9	**GRADE 10**	**GRADE 11-12**
• Different forms of energy; describing energy systems; transfer of energy; potential and kinetic energy. • Energy cannot be destroyed but can be wasted; saving energy; the national electricity supply system. • Renewable and non-renewable sources of energy. • Energy flow in food chains and food webs; energy transfers during respiration, photosynthesis. • Light energy and the visible spectrum. • Electrical energy in electric circuits.	• Introduction to mechanical energy. • Calculating kinetic and potential energy. • Using the principle of conservation of mechanical energy for isolated systems.	• A formal study of work, mechanical energy, energy transfers in electrical circuits, and power. • The work-energy theorem. • Energy transfers in conservative and non-conservative systems.

C Glossary of Terms

TERM	DEFINITION
Kinetic energy	The energy an object possesses as a result of its motion.
Gravitational potential energy	The energy an object possesses because of its position in the gravitational field relative to some reference point.
Mechanical energy	The sum of the gravitational potential energy and kinetic energy.
The law of conservation of mechanical energy	The total mechanical energy in an isolated system/in the absence of dissipative forces, e.g. friction, remains constant. In symbols: $E_{K1} + E_{P1} = E_{K2} + E_{P2}$
Energy	The ability to do (mechanical) work.
Potential energy	Stored energy.
Dissipative force	A force which causes a loss in energy when motion occurs, mainly through friction, and through air resistance.
Isolated system	A system that does not interact with its surroundings, i.e. there is no transfer of energy or mass between the system and the surroundings.
The law of conservation of energy	The total energy of an isolated system remains constant.
Friction	Force which resists the motion of an object moving relative to another.
Air resistance	Force which is exerted by the air in the opposite direction to the motion of an object.
In free-fall	An object is in free-fall when the only force that acts on it is the force of gravity (weight).
Weight	The force due to gravity.

D Assessment of this Topic

This topic is assessed by informal and control tests, and final examinations.

- There may be multiple-choice type questions and problems to solve, where the learners are expected to show their method, give some explanation and/or write down definitions or laws.

E Breakdown of Topic and Targeted Support Offered

- Please note that this booklet does not address the full topic – only targeted support related to common challenges is offered.
- For further guidance on full lesson planning, please consult CAPS, the NECT Planner & Tracker and the textbook.

TIME ALLOCATION	SUB TOPIC	CAPS PAGE NUMBER	TARGETED SUPPORT OFFERED
1.5 hours	Gravitational potential energy	58	1. Key concepts and possible misconceptions are clarified and explained: a. Energy (explained at onset – to avoid confusion) b. Potential (scientific context) c. Gravitational potential energy 2. Calculations are modelled and practised at different levels: a. Introduction level calculations involving $E_P = mgh$ b. Challenge level calculations involving $E_P = mgh$.
1.5 hours	Kinetic energy	58	1. Key concepts and possible misconceptions are a. clarified and explained: b. Kinetic (scientific context) c. Kinetic energy 2. Calculations are modelled and practised at different levels: a. Introduction level calculations involving $E_K = ½ mv^2$ b. Challenge level calculations involving $E_K = ½ mv^2$
1 hour	Mechanical energy	58	1. Key concepts and possible misconceptions are clarified and explained: a. Mechanical energy 2. Calculations are modelled and practised at different levels: a. Introduction level calculations involving $E_M = E_K + E_P$ b. Challenge level calculations involving $E_M = E_K + E_P$

4 hours	Conservation of mechanical energy (in the absence of dissipative forces)	59	1. Key concepts and possible misconceptions are clarified and explained: a. Conservation of mechanical energy 2. Calculations are modelled and practised at different levels: a. Introduction level calculations that use the law of conservation of mechanical energy to solve for an unknown variable at a point b. Challenge level calculations that use the law of conservation of mechanical energy to solve for an unknown variable at a point

F Targeted Support per Sub-topic

1. GRAVITATIONAL POTENTIAL ENERGY

INTRODUCTION TO THE TOPIC

Before beginning the topic, it is important to dispel any misconceptions around some of the scientific terms that will present themselves in this topic, such as 'energy' and 'work'. These terms must be clarified at the outset of the topic, to avoid learners carrying a misconception throughout the topic.

CONCEPT EXPLANATION AND CLARIFICATION: ENERGY

The word "energy" has different meanings in everyday language and science. At the beginning of this topic, take time to clearly distinguish between everyday use and the meaning of energy in terms of physics.

Other disciplines, such as Geography and Life Sciences, also discuss energy and energy transfers. They also have specific ways in which they define terms. Some of these definitions may be the same as those we use in Physical Sciences, but some of these definitions and the use of common terms may differ.

Encourage the learners to make use of the accepted physical science definitions when answering questions and explaining phenomena.

However, no one actually learns about a concept by reciting its definition!

Learning and understanding grow by interacting with ideas. These ideas are then explored through experimentation and explaining the findings in terms of scientific terminology and theories. In a large class, it is useful to give the learners 2 to 3 minutes in small groups to discuss their interpretations of what they are learning about, so that they have the opportunity to make meaning of these. Put a sharp time limit on small group interactions, and collect a few ideas from 3 or 4 groups to check for understanding and to address any difficulties.

Energy is not a substance. Matter is a substance. When we talk about energy being "lost" or "gained" by a system, we are talking about energy transfers and energy changes relative to how much energy was initially present in the system.

Things do not "use up" energy. Energy is transformed from one form to another. It is never used up or destroyed. A vehicle runs on fuel in moving from place to place. The fuel is used up. Some of its chemical potential energy has been transformed into kinetic energy of the vehicle, and the rest has been dissipated to increase the thermal energy of the surrounding environment. Heat is energy in transit. It moves from a hotter place to a colder place. We are unable to make use of the energy which is dissipated; it spreads out in the environment and even to outer space eventually. The principle that energy cannot be created or destroyed applies to the whole universe!

Energy is defined as the ability to do work.

The concept of "work" is handled in Grade 12. Do not define what work is at this stage. Just point tell the learners that in physics when we talk about "work" we are meaning "mechanical work" which is transferred to kinetic or potential energy. We are not referring to the everyday use of the word "work," that it means studying for a test, labouring, going to an office each day, being the shop assistant, and doing what you do each day – that is, teaching!

CONCEPT EXPLANATION AND CLARIFICATION: POTENTIAL ENERGY

Potential energy is also a frequently misunderstood term because in everyday use the word "potential" talks about some ability or talent or skill which will be revealed as time goes on. In our reports to the parents of our learners we sometimes say "she/he has not yet reached her/his potential". It's about an innate ability to achieve good results which we believe the learner has but which she/he has not yet shown.

Well, potential energy is not something which will be revealed in the future. It is energy which is stored now. The learners need to be able to interpret "potential energy" as "stored energy".

The question comes up: How is the energy stored? It is stored by interacting with force in gravitational fields, electric fields and in magnetic fields.

CONCEPT EXPLANATION AND CLARIFICATION: GRAVITATIONAL POTENTIAL ENERGY

At Grade 10 level, we work with gravitational potential energy. Restrict the discussions to gravitational fields so as not to introduce more complexity!

Gravitational potential energy is the energy an object has because of its position in the gravitational field relative to some reference point.

We generally take the reference point as the object's initial position, or we choose ground level as the reference point. We say that at the reference position $E_P = 0$ J.

When the object moves up or down from the reference position its gravitational potential energy changes. We can calculate the change in gravitational potential energy by applying the formula $E_P = mgh$ where h is the difference in height. When an object falls down towards the Earth, it loses gravitational potential energy. If the object is thrown up into the air, it gains gravitational potential energy.

There are many forms of potential energy: nuclear, chemical, elastic, electrical, magnetic, being some of them. This topic is restricted to learning about mechanical energy -

gravitational potential energy and kinetic energy. There is not enough time to deal with all the other forms of energy at this stage.

INTRODUCTORY LEVEL QUESTIONS

a. These are the basic calculations that learners will be required to perform at this stage in the topic.

b. Their purpose is to familiarise the learners with the equation, but not to change the subject of the formula.

How to tackle these questions in the classroom:

- Work through these examples with learners.
- Explain each step of the calculation to the learners as you complete it on the chalkboard.
- Learners must copy the questions down and answer them correctly in their workbooks.

1. A father lifts his child (mass 20 kg) onto a table which is 1,2 m above the ground. Calculate how much gravitational potential energy the child has gained.

Solution

Mass of child = 20 kg	m = 20 kg
Increase in height = 1,2 m	h = 1,2 m
$E_P = mgh$	Use the formula for E_P
$= 20 \times 9,8 \times 1,2$	Substitute the values and $g = 9,8\ m{\cdot}s^{-2}$
= 235,2 J	Calculate the answer. Insert SI units (J).

2. A fisherman catches a fish in his fishing net. The fish has a mass of 2,5 kg and the net has a mass of 250 g. He lifts the net to a height of 0,5 m above the river. Calculate how much gravitational potential energy is gained by the net and the fish when he lifts them.

Solution

Mass of fish = 2,5 kg	
Mass of net = 200 g	Change g to kg: 200 g = $\frac{200}{1000}$ = 0,20 kg
Mass of net and fish = 2,70 kg	Calculate m = 2,70 kg
Increase in height = 0,5 m	h = 0,5 m
$E_P = mgh$	Use the formula for E_P
$= 2,70 \times 9,8 \times 0,5$	Substitute the values and $g = 9,8\ m{\cdot}s^{-2}$
= 13,23 J	Calculate the answer. Insert SI units (J).

CHALLENGE LEVEL QUESTIONS

a. Now that learners have mastered the basic calculations, they are ready to deal with more challenging questions.

b. These questions require learners to manipulate the equation to change the subject of the formula.

How to tackle these questions in the classroom:

- Work through these examples with learners.
- Tell learners that this is a more challenging version of what they have been doing.
- Write the first example on the chalkboard.
- Ask learners to look at the example and see if they can work out what must be done / what is different.
- Discuss learners' ideas, and ask probing questions to extend their answers.
- Try to be positive in these interactions, to encourage critical thinking and questioning.
- Ensure that learners copy down both the question and the solution into their workbooks.

KEY TEACHING:

a. In these more challenging examples, learners must manipulate the data and/or change the subject of the formula, to solve for mass, or the change in height.

b. It is often easier for learners to substitute the values into the equation first, for example: $E_p = mgh$.

c. Once learners have done this, they should then change the subject of the formula.

3. A boy standing on a bridge drops a stone 4,5 m into the river below. What is the mass of the stone, if it loses 158,76 J of gravitational potential during its fall?

Solution

Mass of stone = ?	Unknown
Change in height = 4,5 m	h = 4,5 m
Potential energy = 158,76 J	E_p = 158,76 J
$E_p = mgh$	Use the formula for E_p.
$158{,}76 = m \times 9{,}8 \times 4{,}5$	Substitute the values and $g = 9{,}8\ \text{m·s}^{-2}$.
$m = \dfrac{158{,}76}{9{,}8 \times 4{,}5}$	Change the subject of the formula.
= 3,6 kg	Calculate the answer. Insert SI units (kg).

4. A rock with a mass of 250 kg is stationary at the top of a cliff. In this position, it has 2 000 J of gravitational potential energy. What is the height of the cliff?

Solution

Mass of rock = 250 kg	m = 250 kg
Height of cliff?	Unknown
Gravitational potential energy = 2 000 J	E_p = 2 000 J
$E_p = mgh$	Use the formula for E_p.
$2\,000 = 250 \times 9{,}8 \times h$	Substitute the values and $g = 9{,}8\ \text{m·s}^{-2}$.
$h = \dfrac{2\,000}{250 \times 9{,}8}$	Change the subject of the formula.
= 0,81632 ..	Calculate the answer.
= 0,82 m	Round up to 2 decimal places. Insert SI units (m).

2. KINETIC ENERGY

INTRODUCTION

It is necessary, before jumping straight to calculations of kinetic energy, to dispel any misunderstandings that learners may have regarding the use of terms and concepts such as:

- Kinetic
- Force
- Energy
- A stationary object has no energy

These terms are often used loosely and in the incorrect context by learners, leading to misconceptions.

CONCEPT EXPLANATION AND CLARIFICATION: KINETIC ENERGY

Kinetic energy is the energy an object possesses as a result of its motion.

Any object which moves, possesses kinetic energy.

Some learners falsely believe that kinetic energy makes (causes) things move. This is a common misconception which arises from a faulty understanding of the definition of kinetic energy. Take a little while to check that your learners know "objects possess kinetic energy while they are moving". They have no kinetic energy when they are stationary.

Once you have explained the definition in this way you can go on to discussing what must happen for an object to start moving. There must be a resultant force acting on a stationary object for it to begin to move. The work done by the resultant force is transformed into kinetic energy.

It is useful to note that many learners find it difficult to distinguish between force and energy. Forces act on objects; pushing or pulling them. Objects possess energy as a result of the interaction of forces on them.

Another misconception lies in the notion that "a stationary object (an object at rest) has no energy". It is true that a stationary object has no kinetic energy. But this does not imply that it has no potential energy!

A stationary object can have no mechanical energy. If it is at the reference position its gravitational potential energy is zero, and because it is not moving, its kinetic energy is zero. However, if it is above or below the reference position, it will possess gravitational potential energy.

INTRODUCTORY LEVEL QUESTIONS

a. These are the basic calculations that learners will be required to perform at this stage in the topic.

b. Their purpose is to familiarise the learners with the equation, but not to change the subject of the formula.

How to tackle these questions in the classroom:

- Work through these examples with learners.
- Explain each step of the calculation to the learners as you complete it on the chalkboard.
- Learners must copy down the questions and answer them correctly in their workbooks.

5. How much kinetic energy does a car with a mass of 1 200 kg have when it travels at 20 $m \cdot s^{-1}$?

Solution

Mass of car = 1 200 kg	m = 1 200 kg
Velocity of car = 20 $m \cdot s^{-1}$	v = 20 $m \cdot s^{-1}$
$E_K = \frac{1}{2} mv^2$	Use the formula for kinetic energy.
$= \frac{1}{2} \times 1\,200 \times (20)^2$	Substitute the values. Check v is squared.
= 240 000 J	Calculate the answer. Insert the SI units (J).

6. A 2 ton truck travels at 100 $km \cdot h^{-1}$. What is its kinetic energy?

Solution

Mass of truck = 2 ton	Convert to tonnes to kg: 2 ton = 2 000 kg
Velocity of car = 100 $km \cdot h^{-1}$	Convert to $m \cdot s^{-1}$: $100 \times \frac{1\,000}{60 \times 60} = 27{,}78\ m \cdot s^{-1}$
$E_K = \frac{1}{2} mv^2$	Use the formula.
$= \frac{1}{2} \times 2\,000 \times (27{,}78)^2$	Substitute values. Check you squared v.
= 771 728,4 J	Calculate the answer. Insert the SI units (J).

CHALLENGE LEVEL QUESTIONS

a. Now that learners have mastered the basic calculations, they are ready to deal with more challenging questions.

b. These questions require learners to manipulate the equation to change the subject of the formula.

How to tackle these questions in the classroom:

- Work through these examples with learners.
- Tell learners that this is a more challenging version of what they have been doing.
- Write the first example on the chalkboard.
- Ask learners to look at the example and see if they can work out what must be done / what is different.
- Discuss learners' ideas, and ask probing questions to extend their answers.
- Try to be positive in these interactions, to encourage critical thinking and questioning.
- Ensure that learners copy down the questions and answer them correctly in their workbooks.

KEY TEACHING:

a. In these more challenging examples, learners must manipulate the data and/or change the subject of the formula, to solve for mass, or for speed.

b. It is often easier for learners to substitute the values into the equation first, for example $E_K = ½\ mv^2$.

c. Once they have done this, they should then change the subject of the formula.

7. What is the mass of a vehicle travelling at 15 m·s^{-1} when it has 300 000 J of kinetic energy?

Solution

Mass of vehicle = ?	Unknown
Velocity of vehicle = 15 m·s^{-1}	$v = 15$ m·s^{-1}
Kinetic energy = 300 000 J	$E_K = 300\ 000$ J
$E_K = ½\ mv^2$	Use the formula.
$300\ 000 = ½ \times m \times (15)^2$	Substitute values. Check you squared v.
$m = \dfrac{300\ 000}{½ \times (15)^2}$	Change the subject of the formula.
= 2 666,67 kg	Calculate the answer. Check that you squared the velocity when you calculated the answer. Round up to 2 d.p. Insert the SI units (kg).

8. A ball (mass 500 g) hits the ground with 200 J of kinetic energy. At what speed was it moving just before it hit the ground?

Solution

Mass of ball = 500 g	Convert to kg: 500 g = $\frac{500}{1000}$ = 0,5 kg
Velocity of ball = ?	Unknown
Kinetic energy = 200 J	E_K = 200 J
$E_K = \frac{1}{2} mv^2$	Use the formula for kinetic energy.
$200 = \frac{1}{2} \times 0,5 \times v^2$	Substitute values.
$v^2 = \frac{200}{\frac{1}{2} \times 0,5}$	Change the subject of the formula.
$= 800$	Calculate the answer for v^2.
$v = \sqrt{800}$	Now determine the square root of v^2: $v = \ldots$
$= 28,28\ \text{m·s}^{-1}$	Calculate the answer. Insert the SI units (m·s^{-1}).

CHECKPOINT

At this point in the topic, learners should have mastered:

1. calculating gravitational potential energy.
2. manipulating this equation to calculate one of the other variables in the equation.
3. calculating kinetic energy.
4. manipulating this equation to calculate one of the other variables in the equation.

Check learners' understanding of these concepts by getting them to work through:

Resource Pack: Topic 22: Worksheet: Energy: Questions 1–8. (Page 4).

- Check learners' understanding by marking their work with reference to the marking guidelines.
- If you cannot photocopy the marking guidelines for each learner, make three or four copies of it and place these on the walls of your classroom.
- Allow time for feedback.
- Encourage the learners to learn from the mistakes they make.

3. MECHANICAL ENERGY

INTRODUCTION

Before doing calculations involving mechanical energy, ensure that learners have a clear understanding of what the term means.

CONCEPT EXPLANATION AND CLARIFICATION: MECHANICAL ENERGY

Mechanical energy is the sum of the gravitational potential energy and kinetic energy.

$E_M = E_P + E_K$

INTRODUCTORY LEVEL QUESTIONS

a. These are the basic calculations that learners will be required to perform at this stage in the topic.

b. Their purpose is to familiarise the learners with the concept of mechanical energy.

How to tackle these questions in the classroom:

- Work through these examples with learners.
- Explain each step of the calculation to the learners as you complete it on the chalkboard.
- Learners must copy down the question and answer it correctly in their workbooks.

9. An aeroplane (mass 20 000 kg) flies horizontally at a speed of 250 m·s^{-1} and at a height of 30 km above the ground. Calculate its mechanical energy at that height.

Solution

Mass of plane = 20 000 kg	m = 20 000 kg
Velocity of plane = 250 m·s^{-1}	v = 250 m·s^{-1}
Height of plane = 30 km	Convert to m: 30 km = 30 000 m

$E_M = E_K + E_P$	
$= \frac{1}{2} mv^2 + mgh$	
$= \frac{1}{2} \times 20\,000 \times (250)^2 + 20\,000 \times 9{,}8 \times 30\,000$	Substitute values. Check you squared v.
$= 625000000 + 5880000000$	Calculate each value separately so that you can check the values easily; especially v^2
$= 6\,505\,000\,000$ J	
OR $6{,}505 \times 10^9$ J	Add E_K and E_P. Insert the SI units (J). You may like to express such a large answer in scientific notation.

4. CONSERVATION OF MECHANICAL ENERGY

INTRODUCTION

Now that the concept of mechanical energy is understood, we take it further to the law of conservation of mechanical energy. To understand this concept, the following terms need to be explained fully:

- Isolated system
- Conservation (in this specific scientific context)
- In the absence of friction/dissipative forces

CONCEPT EXPLANATION AND CLARIFICATION: CONSERVATION OF MECHANICAL ENERGY

Energy is conserved in "an isolated system".

The law of conservation of mechanical energy states: The total mechanical energy in an isolated system/in the absence of dissipative forces, e.g. friction, remains constant.

"Conservation laws" in science refer to a quantity which remains constant. However, "conserving energy" in everyday terms means "using the lowest possible amount of the energy source (e.g. electricity) as possible". It is worth addressing these vastly different meanings so that the learners are aware of the difference between the technical and common use of the term "conservation".

An "isolated system" is an ideal system in which there are no other forces acting on it besides the forces and interactions between the objects in the system. It is very difficult to demonstrate an isolated system to the learners, because we always have air resistance and frictional forces to contend with. The energy transfer that takes place when a pendulum bob swings is the easiest demonstration.

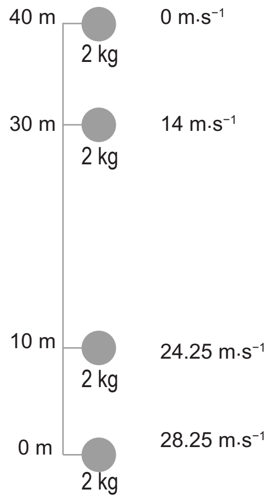
However, the bob slows down each time it changes direction because of the force of the air molecules resisting its motion through the air. It also slows down because of the friction which acts on the string at its pivot point. Friction acts in the opposite direction to motion therefore it "does (mechanical) work" opposing the motion. In both cases the pendulum bob which is swinging in the Earth's gravitational field loses energy to its environment. We cannot say that a pendulum bob is an ideal "isolated system"; we can say it is very close to being an isolated system because the energy transfers are very small in comparison to the initial potential energy of the bob.

It is a very good idea to demonstrate energy transfers of a pendulum. You can attach a tennis ball to a light inextensible (non-elastic) string and clamp it by asking a learner to hold the string tightly and keep her/his hand and fingers still while you set the ball in motion. This "homemade" simple demonstration is actually better than using a retort stand, etc. The learner who is holding the string will feel the string moving between her/his fingers, so she/he can attest to the frictional forces acting at the pivot!

Tell the learners that we ignore the effects of air resistance and friction because at low speeds these forces have very little effect on the motion of objects. Very small amounts of energy are dissipated due to air resistance when the object moves at low speed. This simplifies our calculations and allows us to investigate principles such as the law of conservation of mechanical energy. Later, as the learners move up to Grade 12, they will solve problems in which we take dissipative force and loss of mechanical energy into account.

The mass of the object in the diagram is 2 kg. It is dropped from a height of 40 m and its speed at different heights above the ground is recorded as it falls. The potential, kinetic and mechanical energy are then calculated at different heights.

HEIGHT	E_P	+	E_K	=	E_M
40 m	E_P = mgh = 2 x 9,8 x 40 = 784 J	+	0 J (not moving)	=	784 J
30 m	E_P = mgh = 2 x 9,8 x 30 = 588 J	+	E_K = $\frac{1}{2}$ mv^2 = $\frac{1}{2}$ x 2 x 142 = 196 J	=	784 J
10 m	E_P = mgh = 2 x 9,8 x 10 = 196 J	+	E_K = $\frac{1}{2}$ mv^2 = $\frac{1}{2}$ x 2 x 24,252 = 588 J	=	784 J
0 m	0 J (no height)	+	E_K = $\frac{1}{2}$ mv^2 = $\frac{1}{2}$ x 2 x 282 = 784 J	=	784 J



You can see from the table that as the object falls, its gravitational potential energy decreases, because its height decreases. As the object falls, the kinetic energy increases because it is accelerating and its speed increases until eventually all the gravitational potential energy which it had at the top has been converted into kinetic energy when it reaches the ground.

CHALLENGE LEVEL QUESTIONS

a. Now that learners have mastered the basic calculations, they are ready to deal with more challenging questions.

b. These questions require learners to manipulate the equation to change the subject of the formula.

c. These questions also require learners to use the mechanical energy of an object at one point to calculate an unknown variable at another point, such as height or speed.

How to tackle these questions in the classroom:

- Work through these examples with learners.
- Tell learners that this is a more challenging version of what they have been doing.
- Write the first example on the chalkboard.
- Ask learners to look at the example and see if they can work out what must be done / what is different.
- Discuss learners' ideas, and ask probing questions to extend their answers.
- Try to be positive in these interactions, to encourage critical thinking and questioning.
- Ensure that learners copy the question and answer it correctly in their workbooks.

KEY TEACHING:

a. In these more challenging examples, when learners apply the principle of conservation of mechanical energy to solve a problem, they need to clearly show that they are doing so.

b. This can be achieved by saying "By the principle of conservation of mechanical energy, $E_K + E_P$ remains constant".

c. It can also be done by applying the equation: $E_{K1} + E_{P1} = E_{K2} + E_{P2}$.

d. Question 10.4 shows how this can be set out.

e. Teach the learners how to do this so that their answers are justified by scientific theory.

10. A pendulum bob (mass 200 g) is raised to a height of 50 cm above its rest position, and then it is released. Assume that the system is frictionless and that there is no air resistance.

10.1 State the law of conservation of mechanical energy.

10.2 Explain why this system can be considered as "an isolated system".

10.3 Calculate the maximum potential energy of the bob.

10.4 Determine the maximum kinetic energy of the bob.

10.5 Determine the maximum speed of the bob.

10.6 At what position in its swing will the bob travel at maximum speed?

Solution

10. 10.1 The total mechanical energy in an isolated system/in the absence of dissipative forces, e.g. friction, remains constant.

10.2 The system is isolated because there is no friction and no air resistance therefore no mechanical energy is dissipated while the pendulum (bob) swings.

10.3 Mass of bob = 200 g — Convert to kg: $m = \frac{200}{1000} = 0{,}2$ kg.

Increase in height = 50 cm — Convert to m: $h = \frac{50}{100} = 0{,}50$ m.

$E_P = mgh$ — Use the formula for E_P.

$= 0{,}2 \times 9{,}8 \times 0{,}5$ — Substitute the values and $g = 9{,}8$ m·s^{-2}.

$= 0{,}98$ J — Calculate the answer. Insert SI units (J).

10.4 By the law of conservation of mechanical energy ($E_M = E_K + E_P$) remains constant.

$E_{KA} + E_{PA} = E_{KB} + E_{PB}$

$0 + 0{,}98 = E_{KB} + 0$ — $E_K = 0$ J at A; $E_P = 0$ J at B

$E_K\,max = 0{,}98$ J

10.5 Mass of bob = 0,2 kg

Velocity of bob = ?

$E_K = 0{,}98$ J

$E_K = ½\,mv^2$

$0{,}98 = ½ \times 0{,}2 \times v^2$ — Check that v is squared.

$v^2 = \frac{0{,}98}{½ \times 0{,}2}$ — Change the subject of the formula.

$= 9{,}8$ — Calculate an answer.

$v = \sqrt{9{,}8}$ — v = the square root of v^2.

$= 3{,}13$ m·s^{-1} — Calculate the answer; insert SI units (m·s^{-1}).

10.6 It travels at maximum speed when it passes through its rest position (at the bottom of its path (swing)).

CHECKPOINT

At this point in the topic, learners should have mastered:

1. knowing and understanding the law of conservation of mechanical energy.
2. manipulating the law of conservation of mechanical energy equation to solve for an unknown variable.

Check learners' understanding of these concepts by getting them to work through:

Resource Pack: Topic 22: Worksheet: Energy: Questions 9–10. (Pages 4–5).

- Check learners' understanding by marking their work with reference to the marking guidelines.
- If you cannot photocopy the marking guidelines for each learner, make three or four copies of it and place these on the walls of your classroom.
- Allow time for feedback.
- Encourage the learners to learn from the mistakes they make.

CONSOLIDATION

- Learners can consolidate their learning by completing; **Resource Pack: Topic 22: Energy: Consolidation Exercise. (Pages 6–7).**
- Photocopy the exercise sheet for the learners. If that is not possible, learners will need to copy the questions from the board before attempting to answer them.
- The consolidation exercise should be marked by the teacher so that she/he is aware of each learner's progress in this topic.
- Please remember that further consolidation should also be done by completing the examples available in the textbook.
- **It is important to note that this consolidation exercise is NOT scaffolded. It should not be administered as a test, as the level of the work may be too high in its entirety.**

ADDITIONAL VIEWING/READING

In addition, further viewing or reading on this topic is available through the following web links:

1. https://www.youtube.com/watch?v=IqV5L66EP2E
   This is a good introductory video for learners that explains the concepts of kinetic, potential and mechanical energy, as well as conservation of energy.
2. http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/forces/kineticenergyrev2.shtml
   This is a teacher reference article.
3. http://www.physicsclassroom.com/class/energy/u5l1b.cfm
   This is a teacher reference article.
4. https://phet.colorado.edu/en/simulation/energy-skate-park-basics
   https://phet.colorado.edu/en/simulation/legacy/energy-skate-park
   These two simulations allow you to illustrate the concepts of energy and also to change factors such as mass and height.

TOPIC 23:

Hydrosphere

A Introduction

- This topic runs for 8 hours.
- For guidance on how to break down this topic into lessons, please consult the NECT Planner & Tracker.
- It forms part of the content area Chemical systems (Chemistry) with a weighting of 5 % in the CAPS.
- The hydrosphere counts 6,7 % of the final Paper 2 (Chemistry) examination.
- Understanding the hydrosphere and the water cycle is an extremely important topic and is relevant in today's world where water for human consumption is becoming scarcer, as a result of global warming and climate changes.

CLASSROOM REQUIREMENTS FOR THE TEACHER

1. Chalkboard.
2. Chalk.
3. Periodic Table.
4. Paper 2 (Chemistry) data sheet.

CLASSROOM REQUIREMENTS FOR THE LEARNER

1. An A4 3-quire exercise book, for notes and exercises.
2. Scientific calculator – Sharp or Casio calculators are highly recommended.
3. Pen.
4. Periodic Table.
5. Paper 2 (Chemistry) data sheet.

B Sequential Table

PRIOR KNOWLEDGE	CURRENT	LOOKING FORWARD
GRADE 7-9	**GRADE 10**	**GRADE 11-12**
• The concept of the biosphere. • The biosphere is where life exists and includes the lithosphere, hydrosphere and atmosphere. • It also includes all living organisms and dead and organic matter. • Atoms and subatomic particles. • Pure substances and mixtures. • Chemical reactions. • Balanced chemical equations. • The lithosphere consists of the 'rocks' making up the Earth, i.e. the mantle, the crust and the soil. • The atmosphere and its constituent parts. • Acids and bases and pH.	• Identifying the hydrosphere. • The interaction of the hydrosphere with the atmosphere, the lithosphere and the biosphere. • The effects of dam building on people and on the environment. • Testing water samples for the presence of various anions and pH (recommended experiment). • The purification and quality of water (recommended experiment).	• Not applicable.

C Glossary of Terms

TERM	DEFINITION
Hydrosphere	The water of the Earth. It is found as liquid water (surface and underground), ice (polar ice, icebergs and ice frozen in the soil called permafrost) and water vapour in the atmosphere.
Atmosphere	The body of air surrounding the Earth.
Lithosphere	The solid, rocky crust covering the entire planet.
Biosphere	All the living organisms, i.e. plants and animals.
Water cycle	The processes by which the same water is recycled through the Earth's systems.
Precipitation	Rainfall, hail or snow.
Precipitate	An insoluble solid formed by the reaction of two soluble substances.
Percolation	The process by which water seeps through the lithosphere.
Erosion	The wearing down of rocks or soil by water and wind.
Aquifers	Underground sources of water.
Hydroelectricity	Electricity generated by water.
Sediment	Particles of soil and rock which are carried along by rivers and deposited on its banks.
Micro-organisms	Tiny organisms (germs) that can cause disease.
Flocculation	The joining up of tiny solid particles in water to form larger particles which sink to the bottom of a water container. This process removes these particles from the water.
Permafrost	The frozen water that occurs in frozen layers of soil.
Humidity	This is a quantity that measures the amount of water vapour in the atmosphere.
Aeration	The removal of possibly toxic gases (such as carbon dioxide) in water by spraying water through the air.

D Assessment of this Topic

In Term 3 some learners may have completed "The purification and quality of water" as their project for formal assessment. If so, these learners could contribute to the learning in this topic by presenting some of their findings, and in leading discussions.Recommended project for formal assessment: The purification and quality of water.

E Breakdown of Topic and Targeted Support

- Please note that this booklet does not address the full topic – only targeted support related to common challenges is offered.
- For further guidance on full lesson planning, please consult CAPS, the NECT Planner & Tracker and the textbook.

TIME ALLOCATION	SUB TOPIC	CAPS PAGE NUMBER	TARGETED SUPPORT OFFERED
8 hours	Its composition and interaction with other global systems	60	Key concepts and possible misconceptions are clarified and explained: a. The interaction of the hydrosphere with the biosphere, the atmosphere and the lithosphere. b. The water cycle - refer back to interactions and to the energy changes linked to the various changes of phase that occur. c. The necessity for storing water – learners must understand that there are advantages and also disadvantages to the damming of rivers. d. The quality of the water that we use is very important. Learners must not be under the misconception that water can be used for household purposes without first treating it to eliminate possible threats to health. e. A lot of the undesirable pollutants of water are chemicals in the form of anions. It is recommended that learners watch or do the practical to identify these ions and then relate the tests to water purification.

F Targeted Support per Sub-topic

1. ITS COMPOSITION AND INTERACTION WITH OTHER GLOBAL SYSTEMS

INTRODUCTION TO THE SUB TOPIC

Misconceptions with regards to the water cycle and energy changes will be clarified.

CONCEPT EXPLANATION AND CLARIFICATION: THE INTERACTION OF THE HYDROSPHERE WITH THE EARTH'S SYSTEMS

It must be stressed that the hydrosphere consists of all the Earth's water, whether salt water or fresh water.

- Learners need to understand that the hydrosphere is not a global cycle.
- Throughout this topic, the emphasis should be on the CHEMISTRY of the hydrosphere.
- This topic can be given as a project to save teaching time.

All the Earth's water means the water in the oceans, rivers and lakes. It also includes underground water and frozen water in polar ice, glaciers and in frozen soil (permafrost). Lastly, the water vapour in the atmosphere must also be included.

Water forms an integral part of the Earth and its global systems.

Water at the surface of the Earth evaporates because energy is supplied by the surroundings and especially by sunlight. The evaporated water enters the **atmosphere** as water vapour. The amount of water vapour in the air is measured by what is called "the humidity".

Figure 1 shows the interaction between the hydrosphere and the atmosphere.

1. The sun heats up the water of the ocean, rivers and dams.
2. The water evaporates and rises into the air.
3. The water vapour cools and condenses into droplets which form clouds.
4. Once enough water collects, the drops then return to the ground as rain, snow or hail.
5. Some rain seeps into the Earth. The rest returns back to the rivers and ocean.

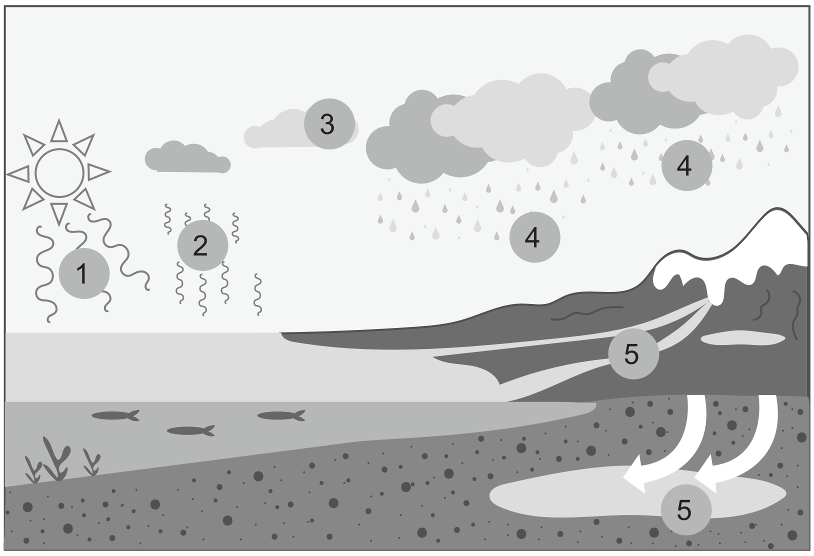


Figure1

All life on Earth is dependent on water. All plants and animals require water to remain alive. So, water interacts closely with the **biosphere**.

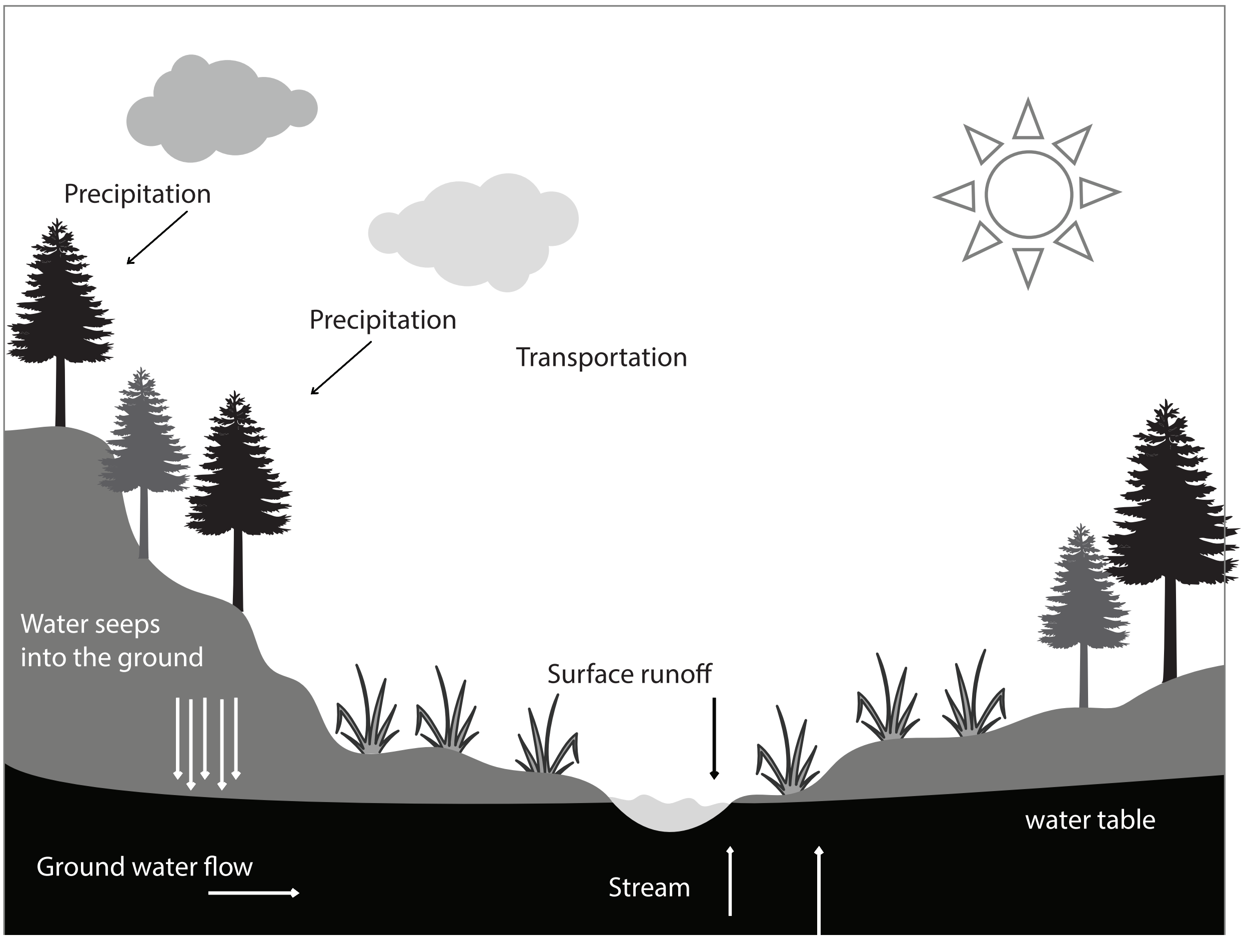


Figure 2 The interaction between the hydrosphere and the lithosphere.

When rain falls on the Earth's surface it runs off rocky surfaces and soil thus eroding the surface. Water also percolates through rock layers and into underground aquifers. This is interaction with the **lithosphere**.

The learners could be split into small groups to discuss the interactions of the various systems with the hydrosphere. At the end of 3 or 4 minutes groups could be asked for a report-back on their discussions.

CONCEPT EXPLANATION AND CLARIFICATION: THE WATER CYCLE

The water cycle is closely related to the interactions of the hydrosphere with other systems.

Learners need to understand that the total amount of water present in the Earth's global systems remains the same and has been the same since Earth was formed (about 2 billion years ago). The water is simply recycled from one form to another.

It is important that learners understand the energy changes involved when water changes from one phase to another. Energy is absorbed when water evaporates and boils. Energy is released when water condenses or freezes.

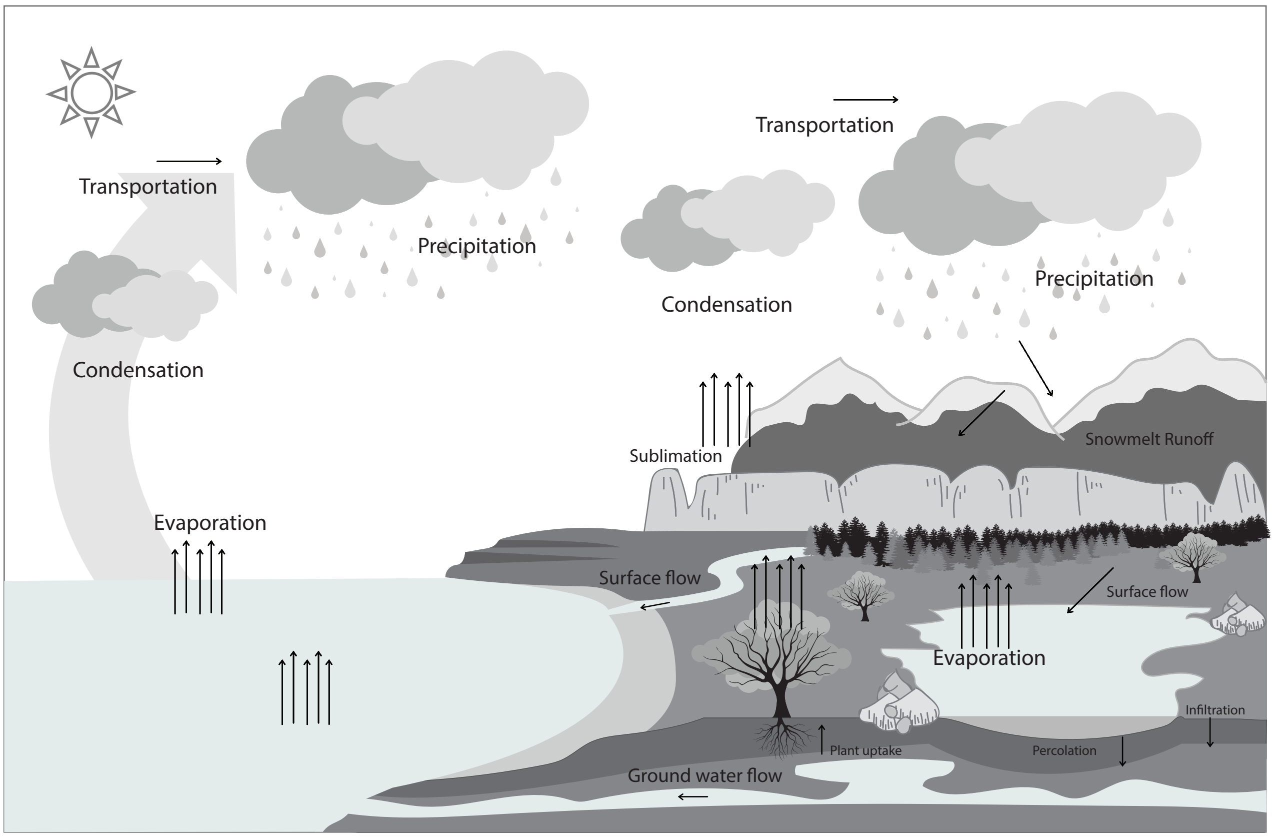


Figure 3 shows the water cycle.

Water evaporates from the surface of the Earth absorbing energy from its surroundings and from sunlight. The water vapour rises in the atmosphere and condenses to form clouds when it reaches cooler layers, releasing energy in the process. Eventually the water droplets in the clouds become large enough to be precipitated as rainfall. Depending on the conditions in the upper atmosphere, the precipitation could also be hail or snow.

The rain eventually reaches rivers, lakes and the sea and the processes of evaporation and condensation are repeated continuously.

As an exercise learners could draw a mind map of the water cycle including the changes of phase and the energy changes involved at each stage.

CONCEPT EXPLANATION AND CLARIFICATION: THE NECESSITY FOR STORING WATER

The building of dams became the norm, to save water. The water saved by damming rivers meant more water available for drinking and for hygiene and more water for irrigating crops. Another advantage of dam building is the use of water in the dam for hydroelectric schemes to provide more energy.

However; learners need to understand that there are disadvantages to the building of dams as well:

- To make room for the water behind the dam wall, people living there have to be moved from their homes.
- The damming of rivers also affects the rest of the river downstream from the dam, such as affecting the strength of river flow and, in turn, farming and fishing. The ecology of the rest of the river will also be affected.
- Large amounts of sediment can deposit behind dam walls, reducing the capacity of the dam to hold water.
- There is a high rate of evaporation from the surface of large dams, which leads to high water losses. This is the case in South Africa where generally dams are shallow and have a large surface area.

Learners could be given topics to research such as:

- Investigating the ecosystems of rivers as compared to that of dams.
- Where feasible, interviews could be carried out with people who have been displaced by dams, to become aware of the problems this causes.
- Investigating how the ecosystems of rivers and the livelihood from rivers downstream have been affected by the building of the dams.

CONCEPT EXPLANATION AND CLARIFICATION: THE QUALITY OF WATER

Water may contain any number of impurities such as:

- Solids
- Dissolved solids
- Dissolved gases
- Micro-organisms

Before water can be used for household purposes any of the above impurities which could be harmful to human beings must be removed.

Water that is taken directly from rivers and dams may contain any of those impurities as well, so water from these sources must be purified.

Water coming into water purification works is first analysed to determine which impurities are present and then appropriate methods are used to remove them. Solids are usually removed by filtration, dissolved solids can be removed by flocculation, dissolved gases (such as carbon dioxide) are removed by aeration and micro-organisms are removed by chemical treatment such as chlorine.

Learners need to be familiar with the methods used for the purification of drinking water. In groups, they could be asked to draw a flow diagram for a water purification plant.

CONCEPT EXPLANATION AND CLARIFICATION: IDENTIFYING IONS IN AQUEOUS SOLUTIONS

Solutions containing the following ions should be tested in the laboratory by learners working in groups:

- Nitrate
- Nitrite
- Chloride
- Carbonate

Each of the solutions is tested using TETRA strips, which give an idea of the quantity of the ions present. TETRA strips are available for pet shops. They are used to test the water quality in fish tanks. A 6-strip TETRA strip which tests for nitrates, nitrites, water hardness, chlorine, alkalinity, pH and dissolved ammonia works really well.

INTRODUCTORY LEVEL QUESTIONS

a. These are the basic questions that learners will be required to answer at this stage in the topic.

b. Their purpose is to familiarise the learners with the content, but not to challenge them at this stage.

How to tackle these questions in the classroom

- Work through these examples with learners.
- Explain each aspect of every concept to the learners as you complete it on the chalkboard.
- Learners must copy down the questions and answer them correctly in their workbooks..

1. Describe the Earth's hydrosphere.

Solution

The Earth's hydrosphere is that system which is made up of all the Earth's water.

2. Write down all the places in which the Earth's water can be found.

Solution

It is found in:

- the oceans
- rivers
- lakes
- the ground
- permafrost

- the atmosphere
- glaciers
- the polar ice caps

3. List the three other systems with which the hydrosphere interacts.

Solution

The three systems are: the lithosphere, the atmosphere and the biosphere.

4. Explain how water in the hydrosphere interacts with the biosphere.

Solution

Every living thing in the biosphere needs water to live. All organisms on the Earth obtain their nutrients from substances that are dissolved in water. The cells of all living things are mostly made up of water.

You need to stress that nothing can live without water. A high percentage of the bodies of animals and of plants is water.

5. Explain how water in the hydrosphere interacts with the lithosphere.

Solution

Water on the surface of the Earth can percolate through the various rocky layers in the Earth's crust. This water finds its way into underground reservoirs and some becomes frozen in the permafrost layers. All crystalline substances in the Earth's crust also have water as part of their crystal structure – this is known as water of crystallisation.

Only in the lithosphere is water found in all three phases.

6. Describe the water cycle.

Solution

Water on the surface of the Earth evaporates into the Earth's atmosphere. When the water vapour reaches cooler layers of the atmosphere it condenses and forms droplets of water. When the droplets are heavy enough that they cannot stay in the atmosphere, they fall back to Earth in the form of rainfall (or hail or snow).

CHALLENGE LEVEL QUESTIONS

a. Now that learners have mastered the basic content, they are ready to deal with more challenging questions.

b. These questions require learners to be creative and to think independently about possible solutions.

How to tackle these questions in the classroom

- Work through these examples with learners.
- Tell learners that this is a more challenging version of what they have been doing. Write the first example on the chalkboard. Ask learners to look at the example and see if they can work out what must be done/what is different.
- Discuss learners' ideas, and ask probing questions to extend their answers. Try to be positive in these interactions, to encourage critical thinking and questioning.
- Next, explain to learners that in these more challenging examples, they must think creatively and come up with creative solutions to the problems.
- In these examples learners will have to think and apply their knowledge to get answers. The answers are not purely factual.
- Ensure that learners copy down the questions and answer them correctly in their workbooks.

KEY TEACHING:

a. For these more challenging examples learners must be encouraged to think independently.

b. Learners must be fully aware of the problems arising from a diminishing water supply and of possible solutions to these problems.

7. Explain what happens at each phase change of the water cycle in terms of the energy changes involved.

Solution

When water evaporates, it is changing phase from liquid to vapour (or gas). In order for this to happen, the water molecules must absorb energy from the surroundings.

Evaporation thus causes cooling of the surroundings. Mention the fact that animals perspire to cool down.

When water condenses in the upper layers of the atmosphere, the phase change is from vapour to liquid and for this change to occur, energy is released by the water particles to the surroundings.

This is also the case when liquid water turns to snow or ice. The change of phase here is from liquid to solid.

8. List three possible ways in which water can be saved.

Solution

- Grow gardens that need little watering using drought resistant plants.
- Water existing gardens less often.
- Use water from the bathroom outlets to water gardens.
- Don't use a hosepipe to wash cars.

Any other practical, creative ideas that may be given – any three.

9. Why should water taken from a river or a dam not be used for household purposes without treating it first?

Solution

Water from dams and rivers is not safe for drinking because it may contain micro-organisms that cause disease or that are toxic. It may contain toxic chemical pollutants which have been washed into the dam or river by farming activities or by industrial plants.

10. How can water from dams or rivers be made safe to drink?

Solution

The water should be boiled for at least 5 minutes or it should be treated with bleach. If treated with bleach, about 2 hours should be allowed before drinking.

You should emphasise that boiling or treating with bleach will destroy micro-organisms but will not remove chemical pollutants.

11. Describe broadly how water is treated for large scale purposes such as for supplying large cities.

Solution

- The water is first analysed to determine what pollutants it contains.
- It is then filtered to remove large solids.
- The water is treated with chemicals to remove any dissolved solids.
- Finally, the water is treated with chlorine to destroy micro-organisms.

12. Two samples of water, A and B, are provided. You are told that one contains dissolved carbonates and the other dissolved chlorides. How can you distinguish between A and B?

Solution

- Add a few drops of a solution of silver nitrate to test tube A.
- If a white precipitate forms, add a few drops of dilute nitric acid.
- If the precipitate persists (doesn't disappear), solution A contains dissolved chlorides.
- To confirm that solution B contains dissolved carbonates, add a few drops of barium nitrate solution.
- If a white precipitate forms, add a few drops of dilute nitric acid.
- If the precipitate dissolves, solution B contains dissolved carbonates.

In the solution containing dissolved carbonates, the barium nitrate reacts with carbonate ions to form barium carbonate, which is insoluble in water – hence the white precipitate. The acid that is then added reacts with the barium carbonate, dissolving it to form barium nitrate once more (which is soluble) and it releases CO_2 *gas.*

Learners should know what salts are soluble in water and they should also know the test for CO_2*.*

CHECKPOINT

At this point in the topic, learners should have mastered:

1. the terminology involved with describing the hydrosphere and its processes.
2. the creative thinking processes relating to answering questions about problems related to water supply.
3. applying what they know about water to related problems.

Check learners' understanding of these concepts by getting them to work through:

Resource Pack: Topic 23: Worksheet: The Hydrosphere: Questions 1–6. (Pages 12–13).

- Check learners' understanding by marking their work with reference to the marking guidelines.
- If you cannot photocopy the marking guidelines for each learner, make three or four copies of it and place these on the walls of your classroom.
- Allow time for feedback.
- Encourage the learners to learn from the mistakes they make.

CONSOLIDATION

- Learners can consolidate their learning by completing: **Resource Pack: Topic 23:**
- **The Hydrosphere: Consolidation Exercise. (Pages 14-15)**.
- Photocopy the exercise sheet for the learners. If that is not possible, learners will need to copy the questions from the board before attempting to answer them.
- The consolidation exercise should be marked by the teacher so that she/he is aware of each learner's progress in this topic.
- **Please remember that further consolidation should also be done by completing the examples available in the textbook.**
- **This consolidation exercise should not be used as a test as the level of the work is altogether of a higher level of thinking.**

ADDITIONAL VIEWING/READING

In addition, further viewing or reading on this topic is available through the following web links:

1. https://www.youtube.com/watch?v=fOwxhITig98 video
   This is a good video for learners and includes all the basic concepts required.
2. https://pmm.nasa.gov/education/lesson-plans/water-cycle teachers
   This is good extra information for teachers and also contains some possible lesson plans.
3. https://www.nationalgeographic.org/activity/our-hydrosphere/ teachers
   Extra reading for teachers.
4. http://learn.mindset.co.za/resources/physical-sciences/grade-10/hydrosphere videos
   This is a set of videos for learners. Teachers should consider how many of them to show learners, depending on the availability of time.